Title: Effective interventions for reducing Diabetes Distress: systematic review and meta-analysis

Running Title: Diabetes Distress review and meta-analysis

Jackie Sturt PhD [1]

Kathryn Dennick PhD [1]

Danielle Hessler PhD [2]

Benjamin M Hunter MSc [1]

Jennifer Oliver PG Diploma [1]

Lawrence Fisher PhD [2]

[1] Florence Nightingale Faculty of Nursing and Midwifery, King's College London, UK

[2] Dept of Family and Community Medicine, University of California San Francisco, USA

Corresponding Author:

Jackie Sturt, Florence Nightingale Faculty of Nursing and Midwifery, King's College London

57 Waterloo Rd, London. SE18WA

Tel: +44 7743190301

Email: jackie.sturt@kcl.ac.uk

Fax: +44 207 848 3680

ABSTRACT

Aims: To identify RCTs in which Diabetes Distress was assessed in adults under experimental conditions and to undertake meta-analysis of intervention components to determine effective interventions for reducing Diabetes Distress.

Methods: Systematic review searching Medline, Psychinfo and Embase to March 2013 for studies measuring Diabetes Distress. Two reviewers assessed citations and full papers for eligibility based on RCT design and PAID or Diabetes Distress Scale outcome measure. Interventions were categorised by content and medium of delivery. Meta-analyses were undertaken by intervention category where ≥7 studies were available. Standardised mean differences and 95% confidence intervals were computed and combined in a random effects meta-analysis.

Results: Of 16,627 citations reviewed, 41 RCTs involving 6,650 participants were included. Twenty one apriori meta-analyses were undertaken. Effective interventions were psycho-education [-0.21 [-0.33, -0.09]], generalist interventionist [-0.19 [-0.31, -0.08]], ≥6 sessions [-0.14 [-0.26, -0.03]] and ≥3 months duration [-0.14 [-0.24, -0.03]]. Motivational interviewing reduced diabetes distress [-0.09 [-0.18, -0.00]] and improved baseline elevated glycaemia [-0.16 [-0.28, -0.04]]. Although statistical significance was observed most effect sizes were below 0.2.

Conclusion: The review signposts interventions likely to reduce elevated Diabetes Distress in type 1 and 2 and across the age profile. Interventional research is needed and warranted targeting elevated distress.

INTRODUCTION

Living with diabetes carries with it an emotional burden with depression, anxiety and eating disorders being amongst the most widely researched (1). A state of distress associated solely with living with diabetes, Diabetes Distress, has developed prominence in the literature over the last decade (2-7) particularly in type 2 populations, although its measurement has been possible since the publication of the Problem Areas in Diabetes Scale (PAID) in 1995 (8). The PAID scale has been widely validated and used in research studies (3-7). It has 20 items and scores on a 0-100 scale. A PAID score of ≥40 is widely accepted to indicate elevated distress (5,9), which is one standard deviation above the mean for patients with diabetes (10). More recently the Diabetes Distress Scale (DDS) has been published with some of the same authors with 17 items a 0-4 response scale and a threshold for distress of 2.5 (11). Diabetes Distress (DD) is characterised by emotional distress in relation to diabetes and its management and has four domains (or sub-scales) of emotional burden, regimen-related distress, diabetes-related interpersonal distress and physician-related distress (11). These four sub-scale domains have reliability and validity and have been employed in research (12, 13).

For people with elevated DD, self-management and the control of glycaemia is a substantial emotional burden. In the UK, 81% of primary care patients with type 2 report 'some degree' of DD [14] and the point prevalence in the community of significant DD is 18%, which increases to almost 30% when any presentation over an 18 month period was considered [2]. In type 1, Byrne et al (2012) reported 39% of their study population to have elevated DD (15). The emotional problems most frequently endorsed by people with diabetes relate to worry about high blood sugar, hypoglycemia and the risk of future complications [2-6,10] and feeling guilty when getting off track with self-management [3-5, 7,8,14]. Crucially, recent work has indicated that only DD demonstrates an independent concurrent association with HbA1c and a time concordant association in which fluctuations in DD correspond with changes in HbA1c over time [16, 17]. The average reduction in DD corresponds with a clinically significant reduction in HbA1c [18, 19]. That DD interferes with self-care in diabetes is supported by clinical observation of one of the authors

(20) although longitudinal evidence is conflicting in this association (17, 21). Evidence has demonstrated a strong association between depression and DD [6, 7]. However, some research has reported that it is depressive symptom severity, rather than major depressive disorder, with which DD is principally related [7, 16]. Recent literature has suggested that DD is more prevalent than major depressive disorder in diabetes [2] which has prompted calls for intervention endeavors to shift from those solely for depression towards targeting DD as a means of improving well-being but also potentially facilitating change in self-management behaviours and important clinical outcomes in diabetes [22,23].

Interventions specifically targeting DD are greatly understudied offering little to inform clinicians how to intervene to reduce DD. Diabetes Distress has been regularly assessed as a secondary outcome in experimental studies [24-28] and these studies may collectively indicate intervention components, not originally designed to target DD, which did so nonetheless. The objective of this paper is to identify experimental studies in which DD was reduced following experimental intervention and to identify the intervention components and characteristics that resulted in clinically significant effect sizes.

METHODS

A systematic review of randomised controlled trials was undertaken using the Preferred Reporting Items for Systematic Reviews and Meta-analyses [PRISMA] guidelines [29]. Population was any adult population with diagnosed type 1 or 2 diabetes, where DD was assessed, irrespective of the intervention focus and the primary outcome.

Data sources and searches

A review of outcome measures assessing DD was undertaken at the outset [30] which resulted in the identification of a small number of outcome measures to assess DD. Because several measures were not widely used and/or fully validated, we only included studies which had used the full Problem Area in Diabetes Scale [PAID] [8] or the Diabetes Distress scale [DDS] [11]. Medline, Psychinfo and Embase databases were searched from 1995 to March 2013 for relevant citations

with no language restrictions. The search strategy (available from the authors) was designed to capture the different terms attributed to the person's experience of diabetes tapped into by these measures of DD, for example *stress, quality of life, diabetes problems, diabetes emotions*. Each citation was assessed by two investigators. We did not employ RCT filters because we were interested in capturing all studies measuring DD. This paper reports only those studies that we identified as RCTs during citation and abstract assessments. All citations/abstracts were assessed for inclusion by two researchers.

Data extraction and quality assessment

Data were extracted by one investigator and quality checked by a second on population and setting, sample size, follow up points, DD measure, outcome data for DD and glycaemic control, experimental and comparison intervention characteristics, including, use of theory, content, medium of delivery, interventionist, focus and intensity. No investigator extracted data from their own included study. Authors were contacted once to request missing outcome data. Where multiple arms were reported, the intervention identified by authors as the most and least active was included. Where studies were reported in more than one paper, they were collated such that the unit of interest was at the study rather than publication level. Studies were excluded from meta-analysis if mixed diabetes populations could not be separated in the results or trials were of equivalence design. We used the Cochrane Collaboration tool for assessing risk of bias (31) to assess for high, unclear or low risk of bias in the adequacy of reporting of sequence generation, allocation sequence concealment, blinding of outcome assessors and outcome data. Assessments were undertaken on all included studies by one author and a 10% sample independently assessed by a second author.

Data synthesis and analysis

Once intervention data were extracted, we built category descriptors (table 1) and these categories formed the basis of our meta-analyses. This resulted in 6 intervention categories and 40 components. Meta-analysis was undertaken where ≥ 7 studies were available for each analysis

enabling 21 meta-analyses including 3 main categories, 3 medium of intervention delivery and 15 analyses of potentially important intervention components effecting DD outcome. The PAID and the DDS were developed by some of the same investigators and, in their respective theoretical justifications and at the item level, similarities between the scales are discernable. Sub group analysis based on outcome measure was not possible owing to insufficient distribution of studies across the subgroups so in view of aforementioned context we conducted the analysis on the combined data set. Diabetes Distress and HbA1c is reported as continuous data, therefore the mean and standard deviation at baseline and follow-up were extracted for each intervention and each outcome. Standardised difference in means [SMDs] and 95% confidence intervals [95% CIs] were then computed based on the endpoint diabetes distress data for each study. Some heterogeneity was anticipated and SMDs were combined in a random effects meta-analysis. Effect heterogeneity was assessed by visual inspection of forest plots and statistical test; Chi-squared [X^2], and quantified using the I^2 index [32]. Percentages of 25%, 50% and 75% indicate low, medium and high heterogeneity respectively. Risk of publication bias was assessed by visual inspection of funnel symmetry in the plots of each trial's SMD against its SE [i.e. funnel plot]. Effect sizes of 0.2, 0.5 and 0.8 are conventionally interpreted as small, medium and large, respectively [33,34]. An effect size of 0.15 was considered clinically important because it would be expected that 6% of the diabetes population would do better than by chance alone [i.e. U3=.56].

Table 1 Construction of apriori intervention categories

RESULTS

Study selection

The search revealed 16,627citations, 1,077 full text papers were retrieved and 298 papers representing 188 unique studies were reviewed [Fig 1]. The reason for study exclusion in the majority of cases was because they did not measure DD. Forty one RCTs were included for which full DD outcome data were obtainable involving 6,650 participants. Six authors provided missing data.

Figure 1. Flowchart of included studies

Study and participant characteristics

Studies were undertaken in 11 countries with 17 undertaken in USA (Tab 2). Diabetes Distress was measured by the PAID in 35 studies and the DDS in 6. Glycemic control was also assessed in 34 studies and depression in 22. Mean participant characteristics were male 47%, mean age 56.5yrs. Ethnicity was reported in 21 studies of which 5 involved a majority of ethnic minority populations, one exclusively Caucasian participants with the remaining 15 having between 1.5-45% of ethnic minority participants. Community settings were represented in 16 studies and hospital diabetes clinics in 14 studies. Type 2 diabetes was the sole or majority population in 34 studies. 1,133 type 1 participants [17% of all review participants] were represented in 8 studies. In 16 studies over 20% of participants were treated with Insulin. Mean DD at baseline ranged from 14.5 – 60 in the 35 studies using the PAID. Mean DD was at, or above, threshold in only seven studies. Mean HbA1c was above 7.5% [58.5 mmol/mol] in 28 studies.

Table 2 Characteristics of included studies

Meta-analysis

The 41 studies contained a wide range of heterogeneous interventions and consequently meta-analysis did not indicate an intervention effect on DD outcome [-0.06 [-0.13, 0.01]. Eleven of the included studies individually found in favor of the comparison arm. Meta-analysis findings by Intervention category and component are detailed in table 3.

Content categories: Psycho-education was the only content category which significantly reduced DD compared to controls [Fig 2]. Psychological, DSME, and Care/Case management categories did not significantly improve DD. There were only three studies in the Drugs/Devices category and on individual inspection of the outcomes, DD was found to be higher in the experimental arm at follow up [SMD 0.03 [-0.18, 0.24] & 0.51 [0.12, 0.89] respectively].

Medium of delivery categories: The format of delivery categories, involving combinations of face to face, remotely delivered and technologically delivered content, did not significantly influence DD outcomes.

Potentially important components: Interventions delivered by generalist clinicians located in primary care resulted in significant DD reductions. Interventions delivered by diabetes specialists, typically working in hospital settings, were not associated with significant reductions [SMD -0.06 [-0.13, 0.01]]. Observation of 5 of the 6 psychologist delivered interventions indicated that the psychologist as interventionist reduced DD significantly relative to control interventionists. Neither group vs. individual formats, the clinical focus of the intervention [E.G. mood, weight loss, glycemic control] nor the presence/absence of theory in driving the intervention effected DD outcome. Intervention intensity of ≥ 6 intervention sessions and duration of ≥ 13 weeks reduced DD compared to controls. Less intensive interventions did not significantly reduce DD. Twenty eight studies had mean baseline HbA1c over 7.5% [58.5 mmol/mol] seven of which offered Motivational Interviewing (population n= 1673). In these seven studies we observed reductions in HbA1c and significant reductions in DD (-0.16 [-0.28, -0.04]. Similar borderline reductions in DD and HbA1c were observed in 11 interventions which had ≥ 6 sessions, (population n=1673) (-0.13 [-0.23 -, 0.04]). Although statistical significance was observed, as noted in table 3, many of these effect sizes were below 0.15 [33, 34].

Figure 2. Forest Plots of intervention effects

Table 3. Apriori sub-group analyses for components associated with reduced Diabetes Distress

Sensitivity analysis and study bias

Sensitivity analyses were undertaken to asses impact of removal of type 1 and mixed sample studies and these were negligible and did not change the overall result of meta-analysis. Risk of bias assessments demonstrated methodological flaws in many of the included studies. Twenty four studies had a high risk of bias, 13 a moderate risk, 3 a low risk, and 1 study in which data was

provided by the author was unable to be assessed. The presence of small and non-significant studies suggest that publication bias was unlikely. Risk of bias data is available from the authors.

DISCUSSION

Our review revealed a considerable number of research studies that have measured Diabetes Distress indicating that researchers, clinicians and people with diabetes regard this as an important diabetes phenomenon. Psycho-education involving diabetes and mood or motivation content, delivered in any format, was significantly associated with reduced distress at follow up. Intervention delivery components which reduced DD involved general clinicians and were of both greater intensity and duration. Intensity of intervention and Motivational Interviewing components were found to significantly reduce both DD and HbA1c.

Psychological problems usually require psychological solutions [35, 36]. Diabetes Distress however appears to respond to psycho-education and affords the diabetes as well as the emotion a central therapeutic position. This might be explained in relation to improvements in diabetes management self-efficacy as there are several included studies that identify reductions in DD alongside improvements in self-efficacy [s2; s9; s11; s22]. People develop mastery in relation to their diabetes management through knowledge and skill acquisition derived from the diabetes content alongside communication, reflection and motivational insights derived from the psychological components. This may enable them to experience a level of control that reduces their sense of helplessness in relation to this complex condition. Continuity and access offered by primary care may explain the significance of the generalist clinician. This finding may arise from the predominance of type 2 studies, reflecting the importance of care close to home facilitating easy access to care, continuity of care and carer and the pastoral elements of general practice relationships. If access and continuity are important for all people with diabetes then it indicates that these outcomes may need to be a focus of interventions to reduce DD, rather than the generalist clinician per sae. This is somewhat contradicted by our finding that combined face to face and remotely delivered interventions, which would facilitate access and continuity, did not appear to influence DD outcome and reinforces the finding that generalists are important.

Motivational interviewing has been widely evaluated to determine its effectiveness in promoting patient self-management across a range of long term conditions [37, 38]. With the exception of trials in diabetes in which findings have been equivocal [39, 40], Motivational Interviewing has been widely considered effective in changing health related behaviours. Motivational Interviewing trials in long term conditions have assessed its effectiveness based on patient reported outcome measures [PROM] whereas diabetes trials have largely focused on evaluating change in glycemic control, a complex biological variable. In our study Motivational Interviewing was assessed using the PAID and the DDS which are PROMs and was found to reduce DD. In trials where this resulted, Motivational Interviewing also reduced elevated HbA1c.This effect was of borderline significance, however so it remains unclear whether it reduces DD, despite reducing HbA1c. Nonetheless, the association between DD and glycaemia in these 7 Motivational Interviewing trials is notable and requires further research attention.

As noted, DD was not influenced by face to face or remote delivery nor by group or 1:1 interactions. There is clinical interest currently in digital clinical communications by email, text, mobile and web portals [41,42] with a rational that they can improve access to health care and therefore might be expected to reduce distress. Our analysis did not find evidence for this. Face to face consultations, solely or in addition to remote access via telephone or digital methods, remained the most frequently delivered experimental intervention. Two of the three included Drugs/Devices interventions, a trial of insulin intensification (s5) and in another of blood glucose monitoring (s37), found DD to be higher in the experimental arm at follow up raising concerns that drug and device intensification can increase DD. As diabetes care becomes increasingly technological around blood glucose monitoring, insulin delivery systems, new drugs, dose titration and web applications to record and analyse the data it is of concern to companies and clinicians that these innovations do not increase DD. The impact of new drugs/doses on health related quality of life is now a major feature of many drug trials [43] and DD may have a place alongside in understanding the diabetes burden associated with innovations in treatments and care.

This is the first review to be undertaken of the published DD literature using a comprehensive search strategy and PRISMA methods [29] resulting in the analysis of a large number of trials with statistical and clinical homogeneity. Ethnicity was reported in half of the included trials and representation of ethnic minority populations in the studies indicates that the meta-analyses broadly represents a diverse population with diabetes. The analysis process of developing intervention categories, from collections of components which could support meta-analyses, was thorough and transparent. The findings enable acceleration of experimental research targeting DD. There are a number of review limitations. DD has been variously described over 2 decades and only 3 databases were searched and it is inevitable that some studies will have been missed. In multiple arm trials (s10,s14,s15,s25,s33,s34,s37,s38,s41), we recognise limitations in selecting the most and least active intervention arms to address the issue of non-independence of effects from an individual study contributing to the meta-analysis. Cochrane advocates that a preferable approach is to define intervention and comparison arms and combine data within these newly formed groups. In the instance of RCT estimating treatment effects of complex interventions such an approach is inappropriate in view of the complex heterogeneity even between the different intervention and control arms within a single study. In effect, the unique effects of differing interventions are averaged out such that the overall estimate does not reflect something meaningful. After careful consideration of alternative approaches offered within the Cochrane handbook (44) we felt our approach to be the most appropriate means of approximating the truth. Twenty four of our 41 included studies were assessed as having a high risk of bias. Removing these studies to undertake sensitivity analyses would have made meta-analyses by intervention category/component not possible. This many studies with a high risk of bias means that some caution is required in interpreting the results. Most effect sizes were lower than 0.2 conventionally regarded as small by Cohen's D [26,27]. The mean DD levels of participants in the trials were below threshold and the next research steps are to develop trials to determine effect sizes when these intervention components are targeted at people with elevated DD at baseline.

Implications for research and practice

Theory and clinical hunch have thus far been the only guidance available to clinicians and researchers in developing interventions to reduce Diabetes Distress. This review is signposting psycho-educational interventions with diabetes and mood/motivation content, delivered more intensively and emphasising access and continuity of care. Many psycho-educational interventions with one or more of these content elements are revealed in our review [s16; s21; s23; s25; s27; s28; s30; s32; s38; s40]. Motivational Interviewing may offer more opportunity in diabetes than thought previously. These now need evaluating in type 1 and type 2 populations with elevated distress in experimental conditions with DD distress as the primary outcome.

Author Contributions

JS developed the idea, screened citations and extracted data. KD developed the protocol and search strategy, screened citations, extracted data and undertook analysis. DH developed the protocol and reviewed the results. BH screened citations and full text papers. JO extracted data and undertook risk of bias assessments. LF developed the protocol and reviewed the results. All authors developed the manuscript.

Acknowledgements

The study was internally funded by the Florence Nightingale Faculty of Nursing & Midwifery, King's College London, the employer of JS and KD. A travel fellowship was awarded to JS by the National Institute for Health Research [NIHR] Mental Health Biomedical Research Centre at South London and Maudsley NHS Foundation Trust and King's College London to fund BH and collaborate with LF & DH. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health.

Conflicts of Interest

The authors have no conflicts of interest to declare

References of included studies

S1	Simson U, Nawarotzky U, Frieset G, Porck W, Schottenfeld-Naort Y, Hahn S, Scherbaum WA, Kruse J. Psychotherapy intervention to reduce depressive symptoms in patients with diabetic foot syndrome. J Diabet Med. 2008;25:206-212
S2	Van der Wulp I, de Leeuw JRJ, Gorter KJ, Rutten GEHM. Effectiveness of peer-led self-management coaching for patients recently diagnosed with Type 2 diabetes mellitus in primary care: a randomised controlled trial. J Diabet Med. 2012;29:e390-e397
S3	Shibayama T, Kobayashi K, Takano A, Kadowaki T, Kazuma K. Effectiveness of lifestyle counseling by certified expert nurse of Japan for non-insulin-treated diabetic outpatients: A 1 year randomized controlled trial. J Diabetic Res Clin Pract. 2007;76:265-268
S4	Rosenbek Minet LK, Wagner L, Lonvig EM, Hjelmborg J, Henriksen JE. The effect of motivational interviewing on glycaemic control and perceived competence of diabetes self-management in patients with type 1 and type 2 diabetes mellitus after attending a group education programme: a randomised controlled trial. J Diabetologia. 2011;54:620-1629
S5	Van den Donk M, KeesJ, Gorter G, Rutten E. No negative effects of a multi-factorial, intensified treatment on self-reported health status, treatment satisfaction, and diabetes-related distress in screen-detected type 2 diabetes patients. The ADDITION – Netherlands Study. J Qual Life Res. 2010;19:509-513
S6	Rygg L, By Rise M, Gronning K, Steinsbekk A. Efficacy of ongoing group based diabetes mellitus. A randomised controlled trial. 2012. J Patient Educ Couns. 2012; 86:98-105.
S7	Sigurdardottir A K, Benediktsson Jonsdottir H. Instruments to tailor care of people with type 2 diabetes. J Adv Nurs 2009;65(10):2118-2130
S8	Zoffman v, Lauritzen T. Guided self-determination improves life skills with Type 1 diabetes and AIC in randomized controlled trial. J Patient Educ Couns. 2006; 64:78-86.
S9	Anderson RM, Funnell MM, Aikens JE, Krein SL, Fitzgerald JT, Nwankwo R, Tannas CL, Tang TS. Evaluating the Efficacy of an Empowerment-Based Self-Management Consultant Intervention: Results of a Two-year Randomized Controlled Trial. J Ther Patient Educ. 2009; 1(1):3-11.
S10	Weinger K, Beverly EA, Lee Y, Sitnokov L, Ganda OP & Caballero AE.The Effect of a Structured Behavioural Intervention on Poorly Controlled Diabetes. Arch Inter Med. 2011: 171:22:1990-1999
S11	Bond GE, Burr RL, Wolf FM, Feldt K. The Effects of a Web-Based Intervention on Psychosocial Well-Being Among Adults aged 60 and Older With Diabetes: A Randomized Trial. J Diabetes Educ. 2010; 36(3):446-456.
S12	Byrne M, Newell J, Coffey N, O'Hara MC, Cooke D, Dinneen SF. Predictors of quality of life gains among people with type 1 diabetes participating in the Dose Adjustment for Normal Eating (DAFNE) structured education programme. Diabetes Res Clin Pract. 2012; 98:243-248.
S13	Fisher L, Polonsky W, Parkin CG, Jelsovsky Z, Amstutz L, Wagner RS. The impact of blood glucose monitoring on depression and distress in insulin-naïve patients with type 2 diabetes. J Curr Med Res Opin. 2011; 27(S3):39-46.
S14	McMahon GT, Fonda SJ, Gomes HE, Alexis, G, Conlin PR. A Randomized Comparison of Online- and Telephone- Based Care Management with Internet Training Alone in Adult Patients with Poorly Controlled Type 2 Diabetes. J Diabetes Technol Ther. 2012; 14(11):1060-1067.
S15	Glasgow RE, Kurz D, King D, Dickman JM, Faber AJ, Halterman E, Woolley T, Toobert DJ, Strycker LA, Estabrooks PA, Osuna D, Ritzwoller D.Twelve-month outcomes of an internet-based diabetes self-management support program. J Patient Educ Couns. 2012; 87:81-92.
S16	Glasgow RE, Nutting PA, Toobert DJ, King DK, Strycker LA, Jex M, O'Neill C, Whitesides H, Merenich J. Effects of a brief computer-assisted diabetes self-management intervention on dietary, biological and quality of life outcomes. J Chronic Illn. 2006; 2:27-38.

S17	Heinrich E, Candel MJJM, Schaper NC, de Vries N. Effect Evaluation of a Motivational Interviewing based counselling strategy in diabetes care. J Diabetes Res Clin Pract. 2010; 90:270-278.
S18	Hermanides J, Norgaard K, Bruttomessot C, Mathieu A, Frids A, Dayan CM, Diem P, Fermontt C, Wentholt IME, Hoekstra JBL, DeVries JH. Sensor-augmented pump therapy lowers HbA_{1c} in suboptimally controlled type 1 diabetes; a randomized controlled trial. J Diabetic Medicine. 2011; *28* 1158-1167.
S19	Hermanns N, Kulzer B, Gulde MA, Eberle H, Pradler E, Patzelt-Bath A, Haak T. Short-Term Effects on Patient Satisfaction of Continuous Glucose Monitoring with the GlucoDay with Real-Time and Retrospective Access to Glucose Values: A Crossover Study. J Diabetes technology & therapeutics. 2009; 11(5):275-282.
S20	Hermanns N, Kulzer B, Maier B, Mahr M, Haak T. The effect of an education programme (MEDIAS 2 ICT) involving intensive insulin treatment for people with type 2 diabetes. J Patient Educ Couns. 2012; 86:226-231.
S21	Lamers F, Jonkers CCM, Bosma H, Knottnerus JA, van Eijk J. Treating depression in diabetes patients: does a nurse administered minimal psychological intervention affect diabetes-specific quality of life and glycaemic control? A randomized controlled trial. J Adv Nurs. 2011 67 (4); 788-799.
S22	Sturt JA, Whitlock S, Fox C, Hearnshaw H, Farmert AJ, Wakelin M, Eldridge S, Griffiths F, Dale J. Effects of the Diabetes Manual 1:1 structured education in primary care. Diabetic Medicine. 2008; 25 (6) :722-731.
S23	Whitemore R, D'Eramo Melkus G, Sullivan A, Grey M. A Nurse-Coaching Intervention for Women with Type 2 Diabetes. Diabetes Educ. 2004; 30(5):795-804.
S24	Hermanns N, Schmitt A, Gahr A, Herder C, Nowotny B, Roden M, Ohmann C, Haak T, Kulzer B. The effect of a diabetes-specific cognitive behavioral treatment program (DIAMOS) for patients with diabetes and sub-threshold depression: results of a randomized controlled trial. Under review.
S25	Welch G, Zagarins SE, Feinberg RG, Garb JL. Motivational Interviewing Delivered by Diabetes Educators: Does It Improve Blood Glucose Control Among Poorly Controlled Type 2 Diabetes Patients? J Diabetes Res Clin Pract. 2011; 91(1):54-60.
S26	Welch G, Allen NA, Zagarins SE, Stamp KD, Bursell SE, Kedziora RJ. Comprehensive Diabetes Management Program for Poorly Controlled Hispanic Type 2 Patients at a Community Health Center. Diabetes Educ. 2011; 37(5):680-688.
S27	Samuel-Hodge CD, Keyserling TC, France R, Ingram AF, Johnston LF, Pullen Davis L, Davis G, Cole AS. A Church-based Diabetes Self-management Education Program for African Americans With Type 2 Diabetes. Preventing Chronic Disease .2006; 3(3):1-16.
S28	Spencer MS, Rosland AM, Kieffer EC, Sinco BR, Valerio M, Palmisano G, Anderson M, Ricardo Guzman J, Heisler M. Effectiveness of a Community Health Worker Intervention Among African American and Latino Adults with Type 2 Diabetes: A Randomized Controlled Trial. Am J Public Health. 2011; 101(12):2253-2260.
S29	Khunti K, Gray LJ, Skinner T, Carey ME, Realf K, Dallosso H, Fisher H, Campbell M, Heiler S, Davies MJ. Effectiveness of a diabetes education and self-management programme (DESMOND) for people with newly diagnosed type 2 diabetes mellitus: three year follow-up of cluster randomised controlled trial in primary care. BMJ. 2012; e2333:1-9.
S30	D'Eramo Melkus G, Chyun D, Vorderstrasse A, Newlin K, Jefferson V, Langerman S. The Effect of a Diabetes Education, Coping Skills Training, and Care Intervention on Physiological and Psychosocial Outcomes in Black Women with Type 2 Diabetes. J Biol Res Nurs. 2010; 12(1):7-19.
S31	Gabbay RA, Anel-Tiangco RM, Dellasega C, Mauger DT, Adelman A, Van Horn DHA. Diabetes nurse case management and motivational interviewing for change (DYNAMIC): Results of a 2-year randomized controlled pragmatic trial. J Diabetes. 2013; 5(3):225-367.

S32	Hermanns N, Kulzer B, Ehrmann D, Bergis-Jurgan N, Haak T. The effect of a diabetes education programme (PRIMAS) for people with type 1 diabetes: Results of a randomized trial, Diabetes Res Clin Pract. 2013; 102:149-157.
S33	Lerman I, Moreira Diaz, JP, Romero Ibarguengoitia ME, Gomez Perez FJ, Villa AR, Velasco ML, Gomex Cruz R, Rull Rodrigo AR. Non adherence to insulin therapy in low-income, type 2 diabetic patients. J Endochrine Practice. 2009; 15(1):41-46.
S34	Quinn CC, Shardell, MD, Terrin ML, Barr EA, Ballew SH, Gruber-Baldini AL,Cluster-Randomized Trial of a Mobile Phone Personalized Behavioral Intervention for Blood Glucose Control. Diabetes Care. 2011; 34:1934-1942.
S35	Beverly EA, Fitzgerald SM, Brooks KM, Hultgren BA, Ganda OP, Munshi M, Weinger K. Impact of Reinforcement of Diabetes Self-Care on Poorly Controlled diabetes: A Randomized Controlled Trial. J Diabetes Educ. 2013; 39:504-514.
S36	Dennick K, Bridle C, Sturt J. Written emotional disclosure for adults with Type 2 diabetes: a primary care feasibility study. J Prim Health Care Res Dev. 2014: doi:10.1017/S1463423614000188
S37	Malanda U, Bot SDM, Kostense PJ, Snoek F, Dekker J & Nijpels G. Effects of self-monitoring of glucose in non-insulin treated patients with type 2 diabetes: design of the IN CONTROL- trial. BMC Family Practice 2009. 10. 26
S38	Pibernik –Okanovic M, Ajdukovic D, Loverencic MV & Hermanns N. Does treatment of subsyndromal depression improve depression and diabetes related outcomes: protocol for a randomised controlled comparison of psycho-education, physical exercise and treatment as usual. Trials 2011: 12:17 doi 10.1186/1745-6215-12-17
S39	Skinner, T. C., Barrett, M. & Greenfield, C. 2011. Impact of providing people with type 2 diabetes with their actual risk for five diabetes complications: A pilot study. Diabetologia Conference: 47th Annual Meeting of the European Association for the Study of Diabetes (EASD) Lisbon Portugal. 12.09.2011 .Diabetologia. 54: 1: S405-S406
S40	Van Son J, Nyklicek I, Pop VJM & Power F. Testing the effectiveness of mindfulness-based intervention to reduce emotional distress in outpatients with diabetes (DiaMind): design of a randomised controlled trial. BMC Public Health. 2011: 11:131 doi:10.1186/1471-2458-11-131
S41	Fisher L, Hessler D, Glasgow R, Arean P, Masharani U, Naranjo D & Strycker L. Redeem: A pragmatic trial to reduce diabetes distress. Diabetes Care. 2013: 36: 2551-2558 USA

References

1. N.H.S. Diabetes. Emotional and psychological support and care in diabetes. *Report from the emotional and psychological support working group of NHS Diabetes and Diabetes UK*. 2010
2. Fisher, L, Skaff, M. M., Mullan, J. T., Arean, P., Glasgow, R., Masharani, U. A longitudinal study of affective and anxiety disorders, depressive affect and diabetes distress in adults with type 2 diabetes. Diabetic Medicine 2008a 25 [9] 1096-1101
3. Snoek F, Pouwer F, Welch GW & Polonsky WH. Diabetes-related emotional distress in Dutch and US Diabetic patients. Diabetes Care 2000 23[9] 1305-1309
4. Delahanty LM, Grant RW, Wittenberg JL, Bosch DJ, Wexler E, Caglieri E & Meigs JB. Association of diabetes-related emotional distress with diabetes treatment in primary care patients with type 2 diabetes. Diabetic Medicine 2007 24, 48-54
5. Hermanns N, Kulzer B, Krichnaum M, Kubiac T & Haak T. How to screen for depression and emotional problems in patients with diabetes: comparison of screening characteristics of depression questionnaires, measurement of diabetes specific emotional problems and standard clinical assessment. Diabetologia. 2006 49 469-477
6. Kokoszka A, Pouwer F, Jodko RR, Mucko P, Bienkowska J, Kuligowska E & Smoczynska Z. Serious diabetes specific emotional problems in patients with type 2 diabetes who have different levels of comorbid depression: A Polish study from the European Depression in Diabetes [EDID] Research Consortium. European psychiatry. 2009 24 425-430
7. Pouwer F, Skinner TC, Pibernik-Okanovic M, Beekman ATF, Cradock S, Szabo S, Metelko Z & Snoek FJ. Serious diabetes-specific emotional problems and depression in a Croatian-Dutch-English survey from the European Depression in Diabetes [EDID] Research Consortium. Diabetes Research & Clinical Practice 2005 70 166-173
8. Polonsky WH, Anderson B, Lohrer PA, Welch G, jaconson AM, Aponte JE & Schwartz CE. Assessment of Diabetes-related distress. Diabetes Care, 1995 18 [6] 754-760
9. Due-Christensen, M., Zoffmann, V., Hommel, E., & Lau, M. (2012). Can sharing experiences in groups reduce the burden of living with diabetes, regardless of glycaemic control? Diabet Med 2012; 29: 251-256
10. Welch G, Jacobson AM & Polonsky WH. The Problem Areas in Diabetes Scale. 1997 Diabetes Care 20 [5] 760-766
11. Polonsky WH, Fisher L, Earles J, et al. Assessing psychosocial stress in diabetes. Diabetes Care. 2005; 28 [3] 626-631
12. Joensen, L. E., Tapager, I., & Willaing, I. Diabetes distress in Type 1 diabetes—a new measurement fit for purpose. Diabet Med 2013; 30: 1132-1139
13. Glasgow, R. E., Edwards, L. L., Whitesides, H., Carroll, N., Sanders, T. J., & McCray, B. L. (2009). Reach and effectiveness of DVD and in-person diabetes self-management education. Chronic Illn 2009; 5: 243-9. doi: 10.1177/1742395309343978.
14. West C & McDowell J. The distress experienced by people with type 2 diabetes. British Journal of Community nursing. 2002 7 [12] 606-613
15. Byrne, M., Newell, J., Coffey, N., O'Hara, M. C., Cooke, D., & Dineen, S. F. (2012). Predictors of quality of life gains among people with type 1 diabetes participating in the Dose Adjustment for Normal Eating (DAFNE) structured education programme. *Diabetes research and clinical practice*, *98*(2), 243-248.
16. Fisher L, Skaff M, Mullan JT, Arean P, Mohr D, Masharani U, Glasgow R & Laurencin G. Clinical depression versus distress among patients with type 2 diabetes. Diabetes Care 2007 30 [3] 542-548

17. Fisher L, Mullan JT, Arean P, Glasgow R, Hesslet D & Masharani U. Diabetes distress but not clinical depression or depressive symptoms is associated with glycaemic control in both cross sectional and longitudinal analyses. Diabetes Care 2010a 33 [1] 23-28

18. Fisher L, Glasgow R & Strycker L. The relationship between diabetes distress and clinical depression with glycaemic control among patients with Type 2 diabetes. Diabetes Care 2010b 33 [5] 1034-1036

19. Levya B, Zagarins S, Allen NA & Welch G. The relative impact of diabetes distress Vs depression on glycaemic control in Hispanic patients following a diabetes self-management education intervention. Ethnicity & Disease 2011 21 322-327

20. Sturt J, McCarthy K, Dennick K, Narasimha M, Sankar S, Kumar S. The Diabetes Listening Intervention: who benefits? Diabetes UK Annual professionals conference 11-13th March 2015.
21. Aitkens J. Prospective associations between emotional distress and poor outcomes in type 2 diabetes. Diabetes Care 2012 35 2472-2478
22. Zagarins S, Allen NA, Garb JL & Welch G. Improvement in glycaemic control following a diabetes education intervention is associated with change in diabetes distress but not change in depressive symptoms. Journal of Behavioural Medicine 2012. 35 299-304

23. Gonzalez J, Fisher L & Polonsky WH. Depression in diabetes: have we been missing something important? Diabetes Care 2011 34 [1] 236-239

24. Weinger K, Beverly EA, Lee Y, Sitnokov L, Ganda OP & Caballero AE. The effect of structured behavioural intervention on poorly controlled diabetes. Arch Intern Med 2011 17 [22] 1990-1999

25. Glasgow RE, Kurz D, King D, Dickman JM, Faber AJ, Halterman E, Wooley T, Toobert DJ, Strycker L, Estabrooks PA, Osuna D & Rizwoller D. Twelve-month outcomes of an Internet-based diabetes self-management support program. Patient education & Counseling. 2012 87 81-92

26. Hermanns N, Kulzer B, Gulde MA, Eberle H, Pradler E, Patzelt-Bath A & Haak T. Short term effects on patient satisfaction of continuous glucose monitoring with Glucoday with real-time and retrospective access to glucose values : a cross over study. Diabetes Technology & Therapeutics 2009 11 5 275-281

27. Welch G, Allen N, Zagarins S, Stamp KD, Bursell SE & Kedziora RJ. Comprehensive diabetes management programme for poorley controlled Hispanic Type 2 patients at a community health centre. The Diabetes Educator. 2011a 37 [5] 680-688

28. Khunti K, Gray L, Skinner T, Carey ME, Realf K, Dalloso H, Fisher H, Campbell M, Heller S & Davies M. Effectiveness of a diabetes education and self management programme (DESMOND) for people with newly diagnosed type 2 diabetes mellitus: three year follow-up of a cluster randomised controlled trial in primary care.BMJ 2012 344 e2333

29. Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine*, 2009 151(4), 264-269.
30. Dennick K, Sturt J & Speight J. What is diabetes distress and how can we measure it? A narrative review [under development]
31. Higgins JP, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, Savović J, Schulz KF, Weeks L, Sterne JAC. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ. 2011; 343: d5928. doi: 10.1136/bmj.d5928

32. Higgins JPT, Thompson SJ, Deeks JJ and Altman DG. Measuring inconsistency in meta-analyses. BMJ. Sep 6, 2003; 327[7414]: 557–560. doi: 10.1136/bmj.327.7414.557

33. Cohen, J. Statistical power analysis for the behavioural sciences. New York: Academic Press. 1988

34. Cohen J. Quantitative methods in psychology: A power primer. Psychological Bulletin, 1992, Vol. 112. No. 1, 155-159

35. Spek V, Cuijpers PC, Nyklicek I, Riper H, Keyzer J, Pop V. Internet-based cognitive behaviour therapy for symptoms of depression and anxiety: a meta-analysis. Psychological Medicine, 2007, 37, 319–328

36. Rosa-Alcázar AI, Sánchez-Meca J, Gómez-Conesa A, Marín-Martínez F. Psychological treatment of obsessive–compulsive disorder: A meta-analysis. Clinical Psychology Review 2008 28 1310–1325

37. Hill, S., & Kavookjian, J. [2012]. Motivational interviewing as a behavioral intervention to increase HAART adherence in patients who are HIV-positive: a systematic review of the literature. *AIDS care, 24*, 583-592.

38. Brodie, D. A., Inoue, A., & Shaw, D. G. [2008]. Motivational interviewing to change quality of life for people with chronic heart failure: a randomised controlled trial. *International Journal of Nursing Studies, 45*, 489-500.

39. Chen, S. M., Creedy, D., Lin, H.-S., & Wollin, J. [2012]. Effects of motivational interviewing intervention on self-management, psychological and glycemic outcomes in type 2 diabetes: A randomized controlled trial. *International Journal of Nursing Studies, 49*, 637-644.

40. Welch G, Zagarins SE, Feinberg RG, Garb JL. Motivational Interviewing delivered by Diabetes educators: Does it improve Blood Glucose control among poorly controlled Type 2 diabetes patients? Diabetes Research & Clinical Practice. 2011. 91 [1] 54-60

41. Sutcliffe P, Martin S, Sturt J, Powell J, Griffiths F, Adams A, et al. Systematic review of communication technologies to promote access and engagement of young people with diabetes into healthcare. BMC Endocrine Disorders 2011. 2011;11:1.

42. Atherton H, Sawmynaden P, Sheikh A, Majeed A, Car J. Email for clinical communication between patients/caregivers and healthcare professionals. The Cochrane Library 2012

43. Food and Drug Administration. Guidance for Industry Patient-Reported Outcome Measures: Use in Medical Product Development to Support Labeling Claims Dec 2009. http://www.fda.gov/downloads/Drugs/Guidances/UCM193282.pdf [accessed 08.03.15]

44. Higgins J & Green S (Ed) Cochrane handbook for systematic reviews of interventions. V5.1.0 March 2011. http://handbook.cochrane.org/ (accessed 07.03.15)

Table 1 Construction of apriori intervention categories

Intervention components	**Possible intervention components**	
Intervention Content (11 components)	CBT; Psychotherapeutic techniques; Supportive counselling; Problem solving; Goal setting/action planning/ solution focused; Motivational consultation; Care planning; Education; Writing intervention; Self-help (bibliotherapy); Drugs and Devices;	
Medium of delivery (12 components)	Telephone support; Online with person support; Online with computer generated support; Text messaging; Audio/visual aids (i.e. CD/DVDs); written materials; health professional involved; peer involved; group; individual; number of sessions; duration of intervention;	
Focus of intervention (12 components)	Diabetes Distress; Other mood/ emotions management; Weight loss; Physical activity; Medication adherence (tablets or insulin); Blood glucose control; Increase knowledge; Behaviour change (in general); Appointment attendance; Carbohydrate counting; Dietary control; Blood glucose monitoring;	
Interventionist (5 components)	Generalist (GP/practice nurse); Diabetes specialist (nurse; dietician); Psychological specialist; Lay person with diabetes; Multi-disciplinary (2 or more different disciplines);	
Stage 2- Building intervention categories from component detail	**Intervention Category title (used in meta-analyses)**	**Criteria**
Cognitive behaviouiral techniques/therapy; Motivational interviewing incl MI techniques; Supportive counselling Psychotherapy	**Psychological**	MI was only included if the MI body of work was referenced in the methods section AND there was detail about which MI techniques were used. Where supportive counselling was the psychological intervention; a minimum of one technique must be identified in the interventional description reflection; supportive listening. Goal setting and problem solving content; in the absence of education but alongside CBT; MI; Supportive Counselling or Psychotherapy; was categorised as **Psychological**.
Education in any format group; 1:1; online; face to face plus a psychological intervention as described in **Psychological** category	**Psycho-educational**	The educational component could be diabetes or mental health related (e.g depression patient education) delivered by health professional or peer. These interventions required 1) an educational currululum; 2) a diabetes or mental health learning opportunity AND 3) either a motivational OR affect component.
Education in any format group; 1:1; online; face to face	**Educational**	No behavioural or skill development elements; purely information about diabetes or a mental health condition.

Education as described in **Educational** category plus goal setting/ planning/ solution focussed/ problem solving components	**Diabetes self-management education (DSME)**	These interventions had NO psychologically therapeutic components.
Drug- Insulin titration or anti-depressant commencement Devices – Continuous Blood Glucose Monitoring or Insulin Pumps	**Drugs & Devices**	Category contains diverse and small number of studies that are less complex (fewer components) and more heterogeneous.
Care management and case management	**Care/case management**	These were interventions focussing on detecting people with the condition of interest (diabetes or diabetes and depression) at either the individual (case) or the cohort level (care) level and delivering an intervention protocol (care planning) focussed on referral, medication, investigation and follow up.

MI Motivational Interviewing; CBT Cognitive Behaviour Therapy; 1:1 one to one

Table 2. Characteristics of included studies

MAIN PAPER & PUBLICATION DATE [OTHER PAPERS] LOCATION	STUDY DESIGN/DD OUTCOME MEASURES/ LONGEST FOLLOW UP	POPULATION AND SETTING SAMPLE [I/C], GENDER, AGE, TI/T2 %, SETTING, INSULIN %	INTERVENTION AND COMPARISON GROUP USED IN META-ANALYSIS	MEAN B'LINE DATA FOR DD AND HBA1C	OTHER ASSESSED OUTCOMES; WAS PRIMARY OUTCOME [P] IN FAVOUR OF INTERVENTION?
SIMSON 2008 GERMANY [S1]	RCT; PAID; End of treatment [discharge]	30 [15/15], male 57%, mean 61yrs, T1 [77%]/T2 [23%], hospital inpatients, 21% Insulin	**Psychologica**l; theory based Psychotherapy with mood focus. Individual face to face delivered by Psych specialist; 5 x 30 min sessions over 6 weeks **Vs Usual Care**	DD I 34.6 [9.4] C 30.9 [17.2]: HbA1c I 7.8% [SD1.5] [62mmol/mol] C 8.7% [SD1.8] [72mmol/mol]	Depressive symptoms [P], anxiety symptoms Yes
VAN DER WULP 2012 NETHERLAND [S2]	RCT; PAID; 6 mth	133 [68/65], males 55%, mean age 61yrs, T2, Primary care, Insulin 3%	**Psychological**; theory based individual Motivational Interviewing and goal oriented lifestyle focus. Peer face to face and telephone delivered. 6 individual 60 min contacts over 3 mths **Vs Usual care**	DD I 16.65 [18.95] C 14.48 [15.50]	Self-efficacy [P], depressive symptoms, psychological well-being, coping, physical activity, dietary habits Yes
SHIBAYAMA 2007 JAPAN [S3]	RCT; PAID; 12mth	134 [67/67], male 65%, mean 62 yrs, T2, hospital clinic. 0% Insulin	**Psychological**; theory based, supportive counselling/goal oriented with behaviour change focus. Face to face with written materials. Diabetes specialist individually delivered monthly x 25 mins [mean] for 12 mths **Vs Usual care**	DD I 40.2 [14.3] C 38.9 [15.9]: HbA1c I 7.3% [56 mmol/mol] C 7.4% [57 mmol/mol]	HbA1c, health-related quality of life, CVD outcomes Primary NR.
ROSENBEK MINET 2011 DENMARK [S4]	RCT; PAID; 24mths	349 [173/176],males 50%, Mean age 56.4yrs, T1 [22%]/T2 [78%], hospital clinic, 38% Insulin	**Psychological**; theory based Motivational and goal oriented with behaviour change focus. Individually delivered face to face by	DD I 20 [17.7] C 19.6 [16.3]: HbA1c I 7.0% [53 mmol/mol] C 7.0% [53mmol/ mol]	HbA1c [P], self-efficacy, CVD outcomes No

			multi-disciplinary team. 5 x 35 min sessions over 12 mths **Vs Usual care**		
VAN DEN DONK 2010 NETHERLAND [S5]	RCT; PAID; 54 mths	498 [255/243], age & gender not reported, T2, screening programme, Insulin NR	**Drug/Devices**; Theory NR. Drug Intensification and education delivered individually & face to face by diabetes specialist. No of sessions NR duration over 3-4 yrs **Vs Usual care**	NR	Health status, treatment satisfaction Primary NR
RYGG 2012 NORWAY [S6]	RCT; PAID; 12 mths	146 [73/73], male 55%, mean 66yrs, T2, General Practice, 18% Insulin	**DSME**; Theory NR. Group education and problem solving, no theory reported. Face to face delivered by MDT and peers with a behaviour change focus. 3 x 5 hr sessions over 1.5 weeks **Vs Wait list control**	DD: I 22.1 [16.4] C 18.2 [16.2]: HbA1c I 7.1% [SD 1.4] [54 mmol/ mol] C 6.9% [SD 1.3] [52mmol/ mol]	HbA1c [P], patient activation [P], treatment satisfaction, knowledge, self-management, global health, health-related QOL, CVD outcomes, health care utilization No
SIGURDARDOTTIR 2009 ICELAND [S7]	RCT; PAID; 6 mths	53 [30/28], male 51%, mean age 60.5yrs [10.5], T2, general practice and hospital clinics, 25% Insulin	**DSME:** theory based education, problem solving and goal oriented, face to face and telephone, individually delivered by diabetes specialist. 1 x 2 hr face to face and 5 telephone contacts over 6 weeks **Vs Usual care**	DD I 24.1 [14.5] C 15.8 [14.5]: HbA1c I 8.1% [SD 0.95] [65 mmol/ mol] C 7.88% [SD 0.89] [63 mmol/ mol]	HbA1c [P], well-being, empowerment, self-management, BMI, waist circumference No
ZOFFMANN 2006 DENMARK [S8]	RCT; PAID; 12mths	61 [36/25], male 48%, mean 36.3yrs, T1, hospital clinic, 100% Insulin	**DSME:** theory based education, self-directed materials, goal oriented with empowerment focus. Group & individual face to face by diabetes educator. 7 x 2 hr sessions over 8 weeks **Vs Waiting list control**	DD I 32 [3.4] C 40.9 [4]: HbA1c I 9.01% [SD 0.02] [75 mmol/ mol] C 9.05% [SD 0.2] [75 mmol/ mol]	HbA1c, autonomy support, treatment self-regulation, frequency of self-monitored blood glucoses, perceived competence in managing diabetes Primary NR

ANDERSON 2009 USA [S9]	RCT; PAID; 24 mths	310 [156/154], male 41%, mean 56yrs, T2, Primary care, Insulin 27%	**DSME:** Theory based, Goal oriented problem solving with written materials individually with diabetes educator with behaviour change focus. Face to face and telephone. Monthly contacts for 24 months **Vs Face to face education only with written materials.**	DD: I 28.3 [21.3] C 28.2 [22.6] HbA1c I 7.7% [SD 2.1] [61 mmol/ mol] C 7.5% [SD 1.8] [58 mmol/ mol]	Diabetes distress [P], HbA1c, summary of self-care diabetes activities; treatment self-regulation, Diabetes self-efficacy; MDRTC's satisfaction sub-scale; Diabetes self-management competence Yes
WEINGER 2011 USA [S10]	RCT; PAID; 14mths	222 [74/75/73], males 46-56% per group, mean age 52.6yrs, T1 [50%/T2 [50%], Diabetes clinic, T2 34% Insulin	**DSME:** Theory based, face to face group education with goal orientation, problem solving, written materials with diabetes educator with BG and BCh focus. 5 x 2hr sessions over 6 weeks **Vs Individual control**	DD I 34.8 [19.3] C 34.0 [21.5]: HbA1c I 9.12% [SD 1.1] [76 mmol/ mol] C 8.9% [SD 1.1] [74 mmol/ mol]	HbA1c [P], self-care inventory; physical activity; 24hr dietary intake; BGM; physical fitness; DD; Anxiety & Depression; diabetes-self-efficacy; coping styles; self-esteem; frustration with self-care and diabetes QOL. Yes
BOND 2010 USA [S11]	RCT; PAID, 6mths	62 [31/31], male NR, mean 68yrs, Type NR, Hospital and community clinics, Insulin NR	**DSME:** Theory NR. Group & individual online with MDT online support. Unrestricted access with 26 weekly MDT sessions for 6 months with focus on emotions and behaviour change **Vs Usual care**	DD: I 2.3 [0.88] C2.1 [0.84]	Depressive symptoms, self-efficacy, social support Primary NR
BYRNE 2012 AUTHOR REPORTED UK [S12]	RCT; PAID, 18mths	437 [Gp size NR] 46% male, mean 41yrs, T1, hospital clinics, Insulin 100%	**DSME:** Theory NR. Group face to face DAFNE programme with a BG control focus delivered by diabetes specialists daily for 5 days **Vs Usual Care**	DD I 30 [18.9] C 29 [18.2]: HbA1c I 8.4% [68 mmol/ mol] C 8.3% [67 mmol/ mol]	Diabetes QOL, HbA1c, anxiety & depression Primary NR
FISHER 2011 USA [S13]	RCT; DDS, 12 mths	483 [256/227], male 53%, mean 56yrs, T2, Primary Care, Insulin 0%	**DMSE;** Theory NR. Individual face to face education, written materials, problem solving, goal orientation with bio-feedback. Generalist HCP	DD I 2.4 [0.98] C 2.25 [0.88]; HbA1c I 8.9% [SD 1.2] [74 mmol/ mol] C 8.9% [SD 1.2] [74 mmol/ mol]	Depression [P], diabetes distress [P], HbA1c No

			delivered 5 sessions over 12 mths with an emotions focus **Vs Enhanced usual care**		
MCMAHON 2012 USA [S14]	RCT; PAID; 12mths	152 [51/51/50], male 95%, mean 62yrs, T2, Veteran's affairs org, Insulin NR	**DSME:** Theory NR. Individual face to face session plus tele-care and education with biofeedback and medication titration with diabetes HCP. Bi-weekly phone calls duration NR. Blood glucose control focus **Vs Individual online care with no HCP**	DD I 24.5 [20] C 29 [19.6]: HbA1c I 9.9% [85 mmol/ mol] C 10.1% [87 mmol/ mol]	HbA1c [P] & CVD outcomes No
GLASGOW 2012 USA [S15]	RCT; DDS; 12mths	463 [132/169/162], male 51%, mean 58yrs, T2, Primary care, Insulin NR	**DSME:** Theory based, Online education, problem solving, goal oriented, Computer-based interactive with health professional telephone support and group face to face sessions with behaviour change focus. Mean logins 2.6-10.45 range per month for 12 months **Vs Usual care**	DD: I 3.3 [0.10] C 3.0 [0.11]; HbA1c I 8.26% [SD 0.13] [67 mmol/ mol] C 8.16% [SD 0.16] [66 mmol/ mol]	Eating behaviours, estimated fat intake; medication adherence, CVD outcomes, self-efficacy, problem solving skills, general health status & HbA1c Primary NR
GLASGOW 2006 USA [S16]	RCT; DDS, 2 mths	335 [174/161], male 50%, mean 62yrs, T2, Primary care, Insulin NR	**Psycho-educational**: Theory based. Single face to face, individual session with general HCP trained in motivational interviewing techniques and goal setting with online education and bio-feedback. Focus on diet and physical activity **vs Enhanced usual care**	DD: I 40.1 [17.5] C 41.5 [18.9]; HbA1c I 7.4% [SD 1.6] [57 mmol/ mol] C 7.5% [SD 1.6] [58 mmol/ mol]	Dietary changes, Depression, HbA1c, Cholesterol Primary NR

HEINRICH 2010 NETHERLAND [S17]	RCT; PAID; 24mths	584 [Number randomized NR], male 46%, mean 59yrs, T2, Primary care, Insulin NR	**Psychological:** Theory based .Face to face, individual Motivational Interviewing and Supportive Counselling with diabetes HCP. 8 x 20 minute sessions every 4 months for 2 years with a behavior change focus **Vs Usual care**	DD I 14.7 [13.05] C 16.48 [13.65]: HbA1c 7.7% [61 mmol/ mol] < 7.0% [<53 mmol/ mol]	Self-management behaviors; Food frequency; Physical activity; CVD outcomes, HbA1c, perceived autonomy, self-efficacy, Health locus of control, knowledge Primary NR
HERMANIDES 2011 EUROPE WITH PI IN NETHERLAND [S18]	RCT; PAID; 6 mths	83 [44/39], male 52%, mean age 38.4yrs, T1, hospital clinics, Insulin 100%	**Drugs/Devices**: Theory NR. Sensor augmented insulin pump supported by face to face individual sessions with diabetes HCP. 3 sessions in 3 months with a blood glucose control focus **Vs Multiple daily injections**	DD I 32.4 [18.8] C 26.5 [18.4]: HbA1c I 8.5% [69 mmol/ mol] C 8.6% [70 mmol/ mol]	HbA1c [P], hypo frequency, QOL, treatment satisfaction, hypo fear Yes
HERMANNS 2009 GERMANY [S19]	RCT crossover; PAID, Discharge at 43hrs	50 [number randomized NR], Male 53%, mean 42yrs, T1, hospital Inpatients, Insulin 100%	**Drugs/Devices**: Theory NR. Continuous Blood Glucose monitor [CBGM] & real time bio-feedback supported by diabetes HCP, face to face, individual sessions during single inpatient stay of 43 hrs with blood glucose focus **Vs CBGM with retrospective bio-feedback of same duration**	DD 30.7: HbA1c 8.1% [65 mmol/ mol]	Continuous glucose monitoring satisfaction, State-Trait anxiety, Depressive symptoms Primary NR
HERMANNS 2012 GERMANY [S20]	RCT; PAID; 6mths	186 [92/94], male 55%, mean age 62.9yrs, T2, diabetes clinics, Insulin 100%	**DSME**: Theory NR. Group face to face with problem solving, goal setting and written materials focusing on blood glucose control in 10 x 90 min sessions **Vs Didactic group education of same length/frequency**	DD: I 52.5 [9.2] C 47.6 [9.6]; HbA1c I 8.5% [SD 1.5] [69 mmol/ mol] C 8.2% [SD 1.1] [66 mmol/ mol]	HbA1c [P], Knowledge, Self-care activities, HRQOL, Weight Yes

LAMERS 2011 NETHERLAND [S21]	RCT; 9mths	PAID,	208 [105/103], male 49%, mean 70yrs, T2, primary care, Insulin 30%	**Psycho-educational:** Theory based. Individual, face to face CBT and written educational components with a general HCP focusing on reducing distress and behavior change over 4 sessions **Vs Usual care**	DD: I 22.6 [20.5] C23.4 [19.5]: HbA1c I 7.5% [SD 1.2] [58 mmol/ mol] C 7.2% [SD1.4] [55 mmol/ mol]	Diabetes symptom distress, HbA1c, Depressive symptoms Primary NR
STURT 2008 UK [S22]	RCT; 6mths	PAID;	245 [114/131], Male 60%, mean 62yrs, T2, primary care, Insulin NR	**DSME**: Theory based. Individual, face to face and telephone supported education with written and audio visual materials delivered by general HCP with behavior change focus. Delivered in 4 x 10min sessions over 12 weeks **vs Waiting list control**	DD I 21 [15] C 21 [15]; HbA1c I 8.9% [SD 1.4] [74 mmol/ mol] C 8.7% [SD 1.4] [72 mmol/ mol]	HbA1c [P], CVD outcomes, self-efficacy No
WHITTEMORE 2004 USA [S23]	RCT; 6mths	PAID;	53 [29/24], male 0%, mean 58yrs, T2, hospital clinic, Insulin NR	**Psycho-educational**: Theory based individual face to face and telephone supported Motivational Interviewing and self-help education with nurse coach. 7 sessions over 5 months with mood, distress and behavior change focus **Vs Usual care**	DD I 59.9 [22] C 42.3 [14]: HbA1c I 7.7% [SD 1] [61 mmol/ mol] C 7.6% [SD 1] [60 mmol/ mol]	HbA1c, BMI, dietary intake, Physical activity, integration and treatment satisfaction Primary NR
HERMANNS [IN PRESS] 2014 GERMANY [S24]	RCT; 12mths	PAID;	214 [106/108], male 43%, mean 43.3yrs, T1 64.5%/T2 35.5%, hospital inpatients, Insulin NR	**Psycho-educational:** Group based diabetes specific CBT with psychologist in 5 x 90 min sessions. Face to face and telephone support. Theory based with focus on mood and behavior change **Vs Group DSME**	DD I 41.1 [19.1] C 37.9 [17.5]; HbA1c I 8.8% [SD 1.7] [73 mmol/ mol] C 8.7% [SD 1.7] [72 mmol/ mol]	Depression, depressive symptoms [P], Wellbeing, treatment satisfaction, QOL, self-care, glycaemic control & CVD outcomes. YES

WELCH 2011 USA [S25]	RCT; PAID, 6mths	234 [58/58/57/61], male 41%, mean 56yrs, T2, hospital clinic, Insulin per group range 22%-46%	**Psycho-educational:** Theory based. Individual motivational interviewing face to face with diabetes specialist plus DSME in 4 x 40mins sessions over 6 months with a behavior change focus **Vs DSME**	DD I 41.9 [22.4] C 43.4 [25.0]: HbA1c 8.9% [74 mmol/ mol]	HbA1c [P], Depression, treatment satisfaction, self-care behaviors. No
WELCH 2011 USA [S26]	RCT; PAID Spanish version, 12mths	46 [21/25], male 33%, mean 56yrs, T2, community clinic, Insulin NR	**Disease management**: Theory NR. Individual web-based assessment and management tool and DSME used by Diabetes HCP and patient in 7 x 1hr face to face sessions over 12 months with online remote interaction. Focus on mood, distress and behavior change **vs Attention control DSME**	DD I 44.3 [23] C 54.2 [24]; HbA1c I 9.0% [75 mmol/ mol] C 8.5% [69 mmol/ mol]	HbA1c, BP, eye exams, Treatment satisfaction, Depression Primary NR
SAMUEL HODGE 2006 USA [S27]	RCT; PAID; 12mths	201 [117/84], male 36%, mean 59yrs, T2, Churches, Insulin 29%	**Psycho-educational**: Theory based. Motivational interviewing, supportive counselling and DSME provided in 25 contacts via individual and group face to face sessions and peer telephone support. Focus on Mood, distress and behavior change by MDT and peers **Vs Usual care**	DD I 23 [20.4] C 22.9 [18.6]: HbA1c I 7.77% [61 mmol/ mol] C 7.79% [62 mmol/ mol]	HbA1c, CVD outcomes, Physical Activity, Food frequency, spirituality, coping styles, health status, perceived diabetes competence, perceived stress, perceived barriers, social support, stages of behavior change Primary NR
SPENCER 2011 USA [S28]	RCT; PAID; 6 mths	164 [72/92], male 38%, mean 52.8yrs, T2, Community, Insulin 27%	**Psycho-educational**: Theory based. Group face to face Motivational Interviewing and DSME with HCP plus individual telephone lay coach support. 11 sessions plus bi-weekly	DD I 23.8 [22.1] C 25.9 [22.8]: HbA1c I 8.55% [70 mmol/ mol] C 8.46% [69 mmol/ mol]	HbA1c, CVD outcomes, knowledge, self management, self-efficacy, physical activity and food practices Primary NR

			telephone calls, duration/frequency NR, with behavior change focus **Vs Wait list control**		
KHUNTI 2012 UK [S29]	RCT; PAID, 36mths	824 [387/437], male 55%, mean 60yrs, T2, primary care, Insulin =/<3%	**DSME**: Theory based face to face group DESMOND education with problem solving, goal setting and written materials with diabetes HCPs. 6 hrs over 1 or 2 sessions with knowledge and behavior change focus **Vs Usual care**	DD NR; HbA1c 8.0% [64 mmol/ mol]	HbA1c [P], CVD outcomes, smoking, Physical activity, QOL, health beliefs, depression, Medication use No
D'ERAMO MELKUS 2010 USA [S30]	RCT; PAID; 24 mths	109 [52/57], male 0%, mean 46yrs, T2, primary care, Insulin 0%	**Psycho-educational**: Theory based. Face to face group CBT & DSME with written materials and self-blood glucose monitoring delivered by trained general HCP. 11 x 90 min weekly sessions with distress and mood focus **Vs Usual care**	DD I 54 [31] C 60 [30]: HbA1c I 8.0% [64 mmol/ mol] C 8.3% [67 mmol/ mol]	HbA1c [P], CVD outcomes, Anxiety, social support, self-efficacy, knowledge, general QOL, health care provider support No
GABBAY 2013 USA [S31]	RCT; PAID; 24mths	545 [232/313],male 42%, mean age 58yrs, T2, primary care, Insulin NR	**Psychological:** Theory based. Individual motivational interviewing face to face sessions with diabetes nurse with telephone/email support as required. 8 sessions over 24 months with empowerment change focus **Vs Usual care**	DD I 29 [23] C 29 [24] HbA1c I 9.05% [75 mmol/ mol] C 8.82% [73 mmol/ mol]	Depressive symptoms, diabetes quality of life, self-care, treatment satisfaction, HbA1c, CVD outcomes and screening attendance. Primary NR
HERMANNS 2013 AUTHOR REPORTED GERMANY [S32]	RCT; DDS; 6mths	160 [81/79], male 56%, mean age 45.5yrs, T1, Diabetes clinic, Insulin 100%	**Psycho-educational:** Theory based. Group face to face using motivational interviewing involving family/friends delivered by diabetes specialist. 12x 90	DD I 1.3 [1] C 1.2 [0.9] HbA1c I 8.3% [67 / mol] C 8.0% [64 mmol/ mol]	HbA1c [P], depressive symptoms, empowerment, self-efficacy, knowledge, self-care behavior, satisfaction with insulin therapy, hypoglycaemia awareness Yes

				min sessions over 6 weeks with a blood glucose control focus **Vs Group education attention control**		
LERMAN 2009 TRANSLATED MEXICO [S33]	RCT; 12mths	PAID;	70 [41/29], male mean across groups 17/33/41%, mean age 57.5yrs, T2, diabetes clinic, Insulin 24%	**DSME:** Theory NR. Individual telephone consultations with general physicians in addition to routine face to face consultations. Monthly calls intensity NR. Behavior change focus **Vs Usual care.**	DD I 45 [23] C 51 [19] HbA1c I 8.5% [SD 1.4] [69 mmol/ mol] C 9.3% [SD 1.9] [78 mmol/ mol]	HbA1c, depression, adherence to treatment [4 questions], diabetes knowledge Primary NR
QUINN 2011 USA [S34]	RCT; 12mths	DDS;	213 [80/33/38/62]; male 50%, mean age 52.9yrs, T2, Primary care, Insulin NR	**DSME:** Theory NR. Individual online/ mobile phone based programme with bio-feedback and educational/ behavioral diabetes nurse coaching. Duration 12 month with ongoing intensity with glycaemic control focus **Vs Usual care.**	DD I 2.4 [0.9] C 2.6 [0] HbA1c I 9.2% [SD 1.7] [77 mmol/ mol] C 9.9% [SD 2.1] [85 mmol/ mol]	HbA1c [P], patient reported diabetes symptoms, depression, CVD outcomes Yes
BEVERLY 2013 USA [S35]	RCT; 12mths	PAID;	134 [67/67], male 49&, mean age 59.1 [8.7], T2, Diabetes clinics, Insulin NR	**DSME:** Theory based. Group face to face education with Conversation maps with diabetes specialist. 4 x 1 hr sessions with behavior change focus **Vs Group didactic education**	DD I 33.3 [20.3] C 34.8 [23.1] HbA1c I/C 8.4% [68 mmol/ mol]	HbA1c [P], psychological symptoms, quality of life, self-efficacy, self-care behaviors, frustration and barriers with diabetes self-management No
DENNICK 2014 UK [S36]	RCT; 3mths	PAID;	41 [23/18], male 61%, mean age 65.5 [9.9], T2, Primary Care, Insulin 10%	**Psychological:** Theory based. Individual written emotional disclosure with no HCP support. 3 x 20min sessions over 1 week with mood focus **Vs Non-**	DD I 37.1 [2.5] C 34.4 [2.3] HbA1c I/C 7.0% [53 mmol/ mol]	Depressive symptoms [P], self-management behaviors, perceived health status No

			psychological writing control		
MALANDA 2011 AUTHOR REPORTED NETHERLAND [S37]	RCT; PAID; 12mths	181 [60/59/62], Male 66%, mean age 61.5 [7.8], T2, Diabetes clinics, Insulin 0%	**Drugs/Devices:** Theory NR. Blood Glucose monitoring with education, Individual **f**ace to face over 2 x 30 min sessions with research assistant with a focus on reducing distress **vs Usual care**	DD I 14.19 [14.7]; C 9.13 [11.0] HbA1c I 7.5% [SD 0.6]; [58 mmol/ mol] C 7.4% [SD 0.6] [57 mmol/ mol]	DD [P], HbA1c, status of depression, patient treatment satisfaction, hypoglycaemia, physical activity, health status, cost-effectiveness and cost-utility. No
PIBERNIK-OKANOVIC 2011 AUTHOR REPORTED CROATIA [S38]	RCT;PAID;12mths	209 [74/66/69], T2, male 62.2%, mean age 58.1, Diabetes clinic and Insulin 30.1%,	**Psycho-educational:** Theory based. Group CBT delivered face to face. Interventionist NR. 6x60-90 min sessions over 6 weeks with mood focus. Interventionist NR **vs Usual care**	DD I 37.63 [20.23]; C 38.04 [18.57] HbA1c I 7.4% [SD 1.3]; [57 mmol/ mol] C 7.1% [SD 1.1] [54 mmol/ mol]	Depressive symptoms [P], HbA1c, self-management, health related quality of life, biochemical markers reflecting insulin resistance, inflammation and oxidative damage. Significance test not available
SKINNER 2011 AUTHOR REPORTED AUSTRALIA [S39]	RCT; PAID; 9mths	56 [29/27], male 54%, mean age 53.9 [11.3], T2, Insulin NR	**DSME:** Theory NR. Individual risk assessment and behavior change counselling for 5 complications delivered face to face and by telephone during 5 sessions over 9 mths with blood glucose control focus. Interventionist NR.**Vs Single session with risk info provided and no coaching/follow up.**	DD I 21 [16] C 14 [10] HbA1c I 8.8% [SD 1.1]; [73 mmol/ mol] C 9.0% [SD 0.9] [75 mmol/ mol]	HbA1c, depressive symptoms, lipids, BP Primary NR
VAN SON 2011 AUTHOR REPORTED	RCT; PAID;6 mths	139 [70/69], male 50%, mean age 56.5yrs, T2 70%, Diabetes clinic, Insulin NR	**Psycho-educational:** Theory based. Group based CBT & Mindfulness programme delivered face to face by psychological	DD I 22.1 [19.7] C 34.8 [20.1] HbA1c I 7.5% [58 mmol/ mol] C 7.6% [60 mmol/ mol]	DD [P], depressive symptoms [P], perceived stress [P], anxiety [P], HbA1c, quality of life, dispositional mindfulness, self-esteem, self-care, BP

NETHERLANDS [S40]			specialist. 8 x 2 hr sessions over 20 weeks with mood focus **Vs Wait list control**		Yes
FISHER 2013 USA [S41]	RCT; DDS; 12mths	392 [146/150/96], male 46%, mean 56yrs, T2, Primary care and hospital clinics, Insulin 18%	**Psychological**: Theory based individual problem solving therapy online and via telephone by a psychological HCP over 1 face to face and 8 telephone sessions of 60mins over 48 weeks with a distress focus **Vs Attention control**	DD I 2.38 [.89] C 2.48 [.95]: HbA1c I 7.34% [57mmol/ mol] C 7.45% [58 mmol/ mol]	Diabetes distress [P], HbA1c, diet, exercise and medical adherence No

DD Diabetes Distress; T1 Type 1; T2 Type 2; RCT Randomised Controlled Trial; PAID Problem Areas in Diabetes Scale; DDS Diabetes Distress Scale; Vs Versus; mth/s Month/s; HbA1c Glycated haemoglobin; yrs Years; BMI Body Mass Index; HRQOL health-related Quality of Life; QOL Quality of Life; I Intervention; C Comparison; NR Not Reported; P Primary Outcome; CVD Cardio vascular disease; DSME Diabetes Self-Management Education; S1-S41 Reference no in supplementary online table 1; BP Blood Pressure. (C)BGM (Continuous) Blood Glucose Monitoring; HCP Health Care Professional; Psych Psychological; hr Hour

Table 3. Apriori sub-group analyses for components associated with reduced Diabetes Distress

Intervention categories & component	No of studies/no of participants	Standardised mean difference [SD] *= < 0.05
CATEGORY		
DSME	17/2910	-0.00 [-0.08, 0.09]
Psychological	8/1519	-0.02 [-0.15, 0.11]
Psycho-educational	11/1551	-0.21 [-0.33, -0.09] *
MEDIUM OF DELIVERY Content		
Face to face only	23/4310	-0.05 [-0.14, 0.04]
Face to face + Remote	15/2086	-0.09 [-0.19, 0.00]
Remote element [in any other type of intervention]	16/2085	-0.08 [-0.16, 0.01]
POTENTIALLY IMPORTANT COMPONENTS		
Diabetes Specialist interventionist	19/3229	-0.03 [-0.12, 0.06]
Generalist Interventionist	7/1246	-0.19 [-0.31, -0.08] *
Use of theory	26/4333	-0.09 [-0.18, 0.01]
Mood focus	15/2041	-0.15 [-0.29, 0.00]
No mood focus	26/4567	-0.01 [-0.08, 0.05]
≤ 5 sessions	18/2923	-0.02 [-0.14, 0.09]
≥ 6 sessions	15/2322	-0.14 [-0.26, -0.03] *
Duration ≤12 weeks	17/2273	0.01 [-0.13, 0.11]
Duration ≥ 13 weeks	13/2676	-0.14 [-0.24, -0.03] *
Motivational Interviewing with/without education	11/1985	-0.09 [-0.18, -0.00] *
Supportive Counselling	9/ 1312	-0.12 [-0.27, 0.03]
Group format	13/2375	-0.08 [-0.22, 0.06]
Individual [1:1] format	27/4178	-0.04 [-0.12, 0.04]

no Number; DSME Diabetes self-management education; + plus; SD Standard deviation; sig Significant